

Remarks/Arguments:

Claims 1-7 and 9-22 are pending.

Allowed Subject Matter

Applicant acknowledges with appreciation the Examiner's finding that claims 1-3, 9-14, and 17-22 are allowed. Applicant notes, however, that the Office Action at page 10 states that claims 7 and 17 are "allowable". Applicant assumes that this is a typographical error because claim 7 is an independent claim with claim 17 directly dependent thereon.

Claim Rejections Under Section 103

Claims 4 and 15 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Kuriyama in view of Kojima and Kawguchi. Applicant respectfully traverses this Section 103(a) rejection.

Claim 4 is an independent claim to which claim 15 is directly dependent.

Claim 4 calls for a field emission type electron source device including the following elements:

- a field emission electron source portion including an extraction electrode provided on a p-type silicon substrate via an insulating film and having an opening portion at a position corresponding to a region where a cathode is provided, and a cathode portion provided on the p-type silicon substrate and at a position corresponding to the opening portion of the extraction electrode, and
- an n-channel field effect transistor portion provided on the p-type silicon substrate, corresponding to the field emission electron source portion,
- the field emission electron source portion is provided in a drain region of the field effect transistor portion, and a control voltage is applied to a gate electrode of the field effect transistor portion to control a field emission current from the field emission electron source portion,
- the gate electrode of the field effect transistor portion has a shape such that a portion of the gate electrode nearer the drain region has a total width wider than a total width of a portion of the source electrode nearer the source region, and a

part of the gate electrode is provided in such a manner as to cover an end of the drain region.

Applicant respectfully submits that claim 4 and dependent claim 15 are patentably distinguished from the references of record because the references of record do not teach or suggest the feature of independent claim 4 that "a part of the gate electrode is provided in such a manner as to cover an end of the drain region". An advantage associated with the above-identified feature of claim 4 is that electrons injected from the source of the field effect transistor move along the channel formed under the gate electrode. As a result of this structure, the electron flow path is enlarged in the n-channel field effect transistor portion, and drain current density is more efficiently reduced in the drain end portion of the gate electrode. Accordingly, degradation of the field effect transistor performance because of hot electrons is significantly reduced. This advantage is discussed in the application at, for example, page 30, lines 8-21.

The Examiner has taken the position in the Response to Arguments section of the Office Action that the above-identified feature is taught in Fig. 3 of the Kuriyama Patent because the gate 8 is positioned over n-type silicon region 4 which is connected to the drain region. The Examiner goes on to contend that because the n-type silicon region 4 is connected to the drain region 6, then the n-type silicon region 4 also forms part of the drain region. Applicant respectfully disagrees with this reasoning.

Applicant points out that the Kuriyama Patent clearly discloses two separate regions; namely the n⁺-type silicon drain region 6 and the n-type silicon channel region 4. Thus, n-type silicon channel region 4 is not and cannot be part of the drain region. Thus, there is no technical basis for the position set forth in the Response to Arguments section of the Office Action.

In addition, the Kuriyama Patent describes that the electric current starts from the emitter 1 and flows along n⁺-type silicon drain region 6, n-type silicon region 4 to arrive at the source electron 7. This electric current flow is in the opposite direction of the flow of electrons in applicant's claimed invention, which flows from the source of the field effect transistor, as noted above.

Based on the foregoing discussion, applicant respectfully submits that the Kuriyama Patent can neither anticipate nor render obvious the field emission type electron source device defined in claim 4, as well as dependent claim 15.

Applicant also contends that the Kojima and Kawaguchi Patents do not rectify the deficiencies heretofore discussed with respect to the Kuriyama Patent. Applicant therefore requests that the Section 103(a) rejection directed to claims 4 and 15 be withdrawn.

Claims 5 and 16 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Kuriyama in view of Kojima. Applicant respectfully traverses this Section 103(a) rejection.

Claim 5 is an independent claim with claims 6 and 16 dependent thereon.

Independent claim 5 is directed to a field emission type electron source device and includes the following features:

- a field emission electron source portion including an extraction electrode provided on a p-type silicon substrate via a first insulating film and having an opening portion at a position corresponding to a region where a cathode is provided, and a cathode portion provided on the p-type silicon substrate and at a position corresponding to the opening portion of the extraction electrode, and
- an n-channel field effect transistor portion provided on the p-type silicon substrate, corresponding to the field emission electron source portion,
- the field emission electron source portion is provided in a drain region of the field effect transistor portion, and a control voltage is applied to a gate electrode of the field effect transistor portion to control a field emission current from the field emission electron source portion,
- the drain region includes at least two wells having different impurity concentrations, a first of the at least two wells being provided around a circumference of the second of the at least two wells,
- **a gate insulating film is provided between the gate electrode and the field effect transistor and the p-type silicon substrate, the gate insulating film is a film thinner than the first insulating film, the first insulating film being provided between the extraction electrode and the p-type silicon substrate, and the gate electrode is buried with the first insulating film.**

Applicant submits that the field emission type electron source device defined by claim 5 is patentably distinguished from the references of record at least based on the requirement of a gate insulating film being provided between the gate electrode of the field effect transistor and the p-type silicon substrate, with the gate film being a film thinner than the first insulating film,

and the first insulating film being provided between the extraction electrode and the p-type silicon substrate, and the gate electrode being buried with the first insulating film (herein after generally referred to as the "Gate Insulating Film and First Insulating Film Feature") of applicants' claimed invention. Simply put, the Gate Insulating Film and First Insulating Film Feature is neither taught nor suggested in any of the references of record.

The advantage of this Feature is discussed in the subject application, for example, see page 35, lines 9-21. The gate insulating film (the lower insulating film) needs to be of good quality and be thin. But both the gate insulating film and the adjacent first insulating film must be used combined as a multi-layer, thick insulating film to insulate the extraction electrode to which a high voltage of several tens of volts is typically applied. Thus, when the Gate Insulating Film and First Insulating Film Feature is used, a gate insulating film for a field effect transistor and an insulating film for a field emission type electron source are separately designed which makes it easy to attempt to obtain a high performance element.

According to the above discussion of the Gate Insulating Film and First Insulating Film Feature, it is apparent that two separate insulating films are used in applicant's claimed invention, and both insulating films have separate functions. Such is not taught or suggested in the Kuriyama Patent because the Kuriyama apparatus has only a single insulator layer 3 (as shown in Figs. 1-4). Thus, the insulator layer of Kuriyama would not function as described in applicant's field emission type electron source device set forth in claim 5.

The Examiner contends in the Office Action that there is a gate insulating film between the substrate and the gate of the apparatus of Kuriyama. In this connection, the Examiner points to col. 5, lines 4-11 of the Kuriyama Patent which describes a small electric field along a surface of p-type silicon 5 under gate electrode 8. Applicant respectfully submits, however, that this structure is not equivalent to the claimed gate insulating film defined in applicant's claim 5. The presence of an electric field does not constitute a separate layer. Thus, the Kuriyama Patent does not teach the Gate Insulating Film and First Insulating Film Feature of applicant's claimed invention, nor does the Kuriyama Patent teach or suggest the advantage of the separate insulating films as discussed above.

It is applicant's further contention that the Kojima Patent (which has only been cited with respect to a well having low impurity concentration) does not rectify the deficiencies heretofore discussed with respect to the Kuriyama Patent relative to the Gate Insulating Film and First Insulating Film Feature of applicant's claimed invention.

Based on the foregoing discussion, applicant respectfully submits that claim 5, as well as dependent claims 6 and 16, are patentably distinguished from the Kuriyama and Kojima Patents. Applicant requests that the Section 103(a) rejection be withdrawn.

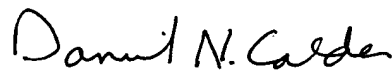
Claim 6 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Kuriyama and Kojima in view of Hirano. Applicant respectfully traverses this Section 103(a) rejection.

As noted above, claim 6 is directly dependent on claim 5 and therefore includes the Gate Insulating Film and First Insulating Film Feature of applicant's claimed invention. Based on this Feature, claim 6 is patentably distinguished from the Kuriyama and Kojima Patents according to the discussion above.

The Hirano Reference is directed to a cold electron emitting element and has been cited primarily with respect to the use of thermal oxidation of silicon. But simply put, there is no teaching or suggestion in the Hirano Reference which rectifies the deficiencies heretofore discussed with respect to the Kuriyama and Kojima Patents. Thus, the Section 103(a) rejection of claim 6 should be withdrawn.

In view of the foregoing remarks, applicant respectfully submits that pending claims 1-7 and 9-22 are either allowed or in condition for allowance. Reconsideration and allowance of all pending claims are respectfully requested.

Respectfully submitted,



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